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A609 A613 A615 A61Y A671 A673 A675 A677  
A679 A67X A681 A683 A685 A687 A689 A68X  
A693 A695 A697 A699 A69X A70X  
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(56) Documents cited

**GB 1189280 GB 1154222 GB 0766256  
GB 0630138**

(58) Field of search

**C7A  
Selected US specifications from IPC sub-class  
C22C**

(54) Alloy for a disk rotor

(57) An alloy for a disk rotor utilized in disk brakes contains 2.3 to 3.0 wt.% of silicon, 1.0 to 3.0 wt.% of manganese, 0.2 to 1.0 wt.% of chromium, 0 to 2.0 wt.% of copper and 3.7 to 4.2 wt.% of carbon, the remainder being inevitable impurities and iron.

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Fig. 1

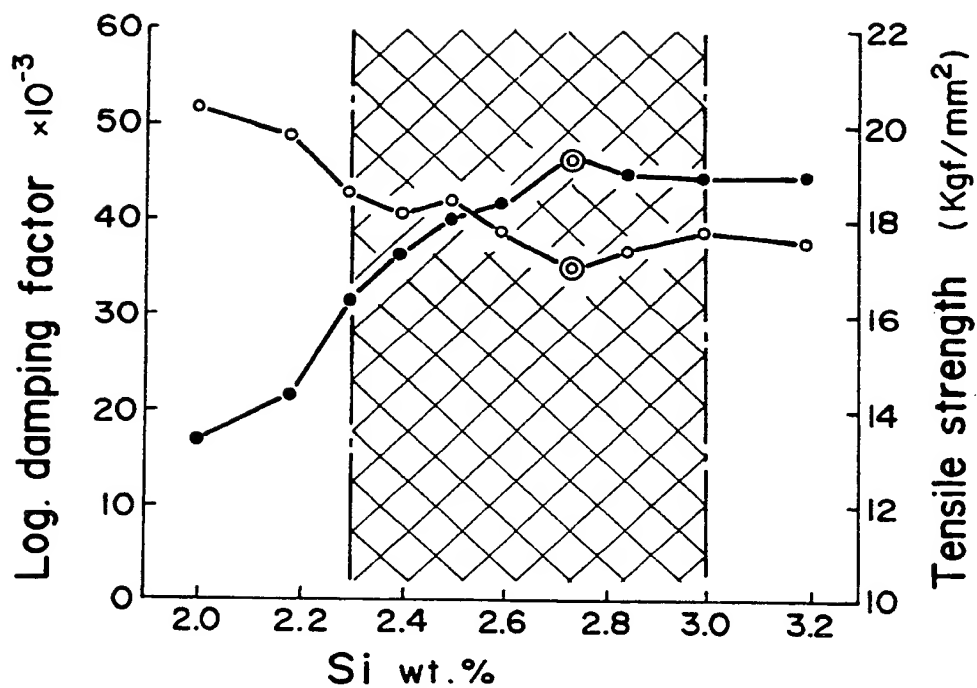


Fig. 2

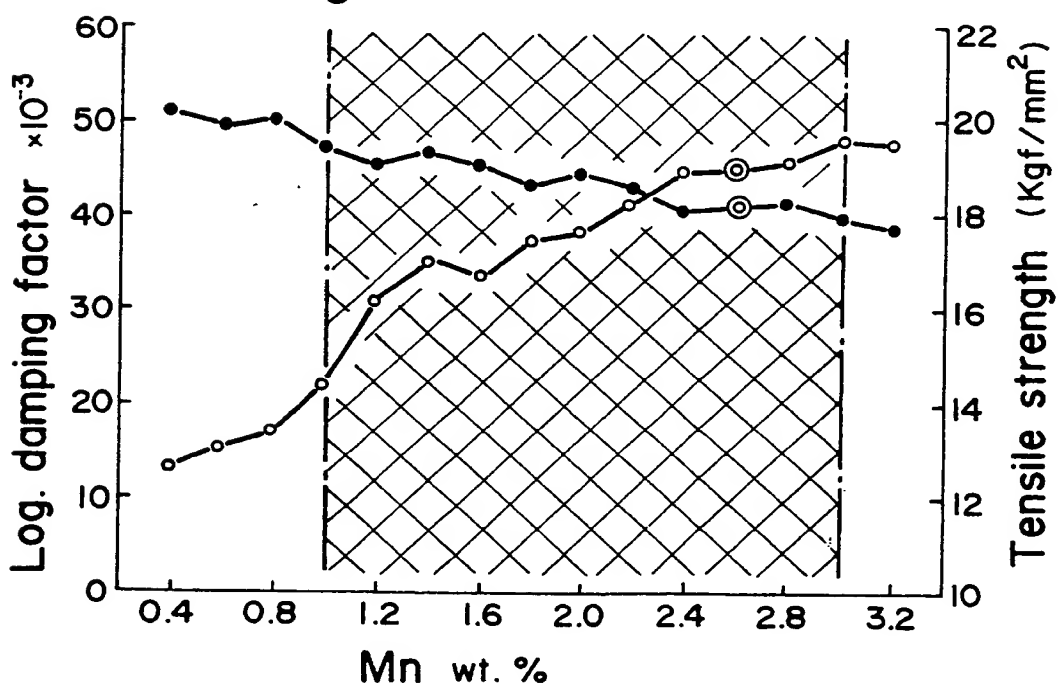


Fig. 3

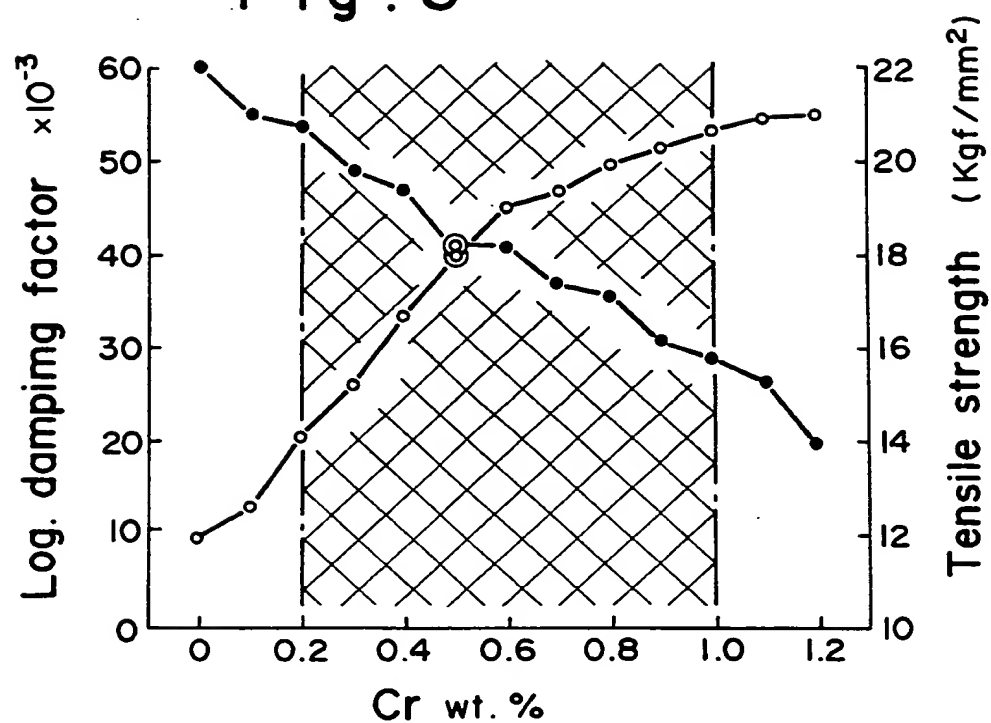


Fig. 4

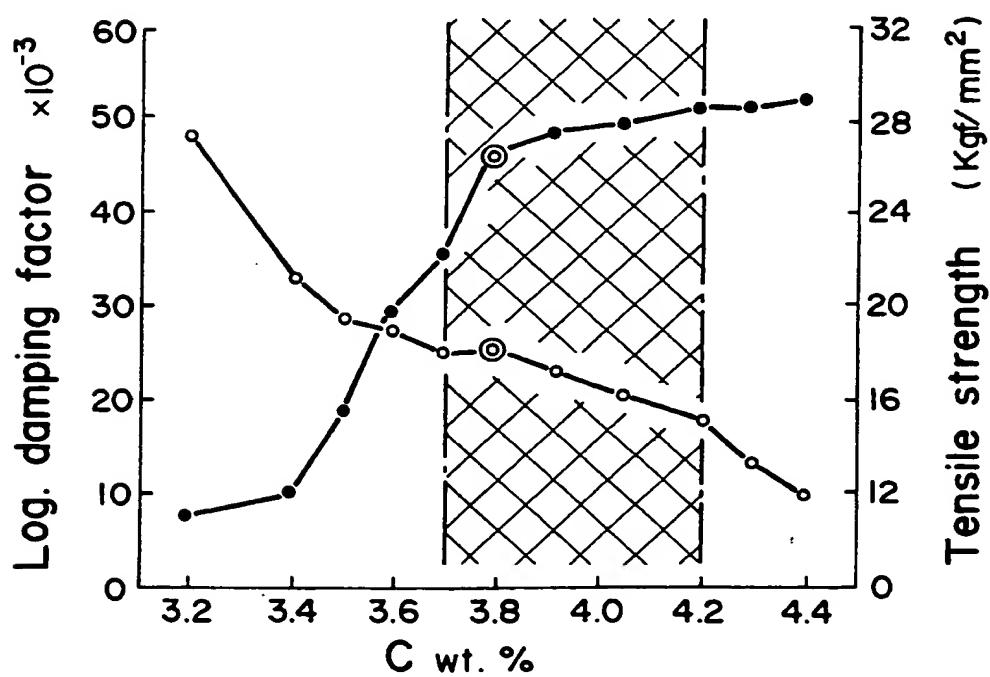
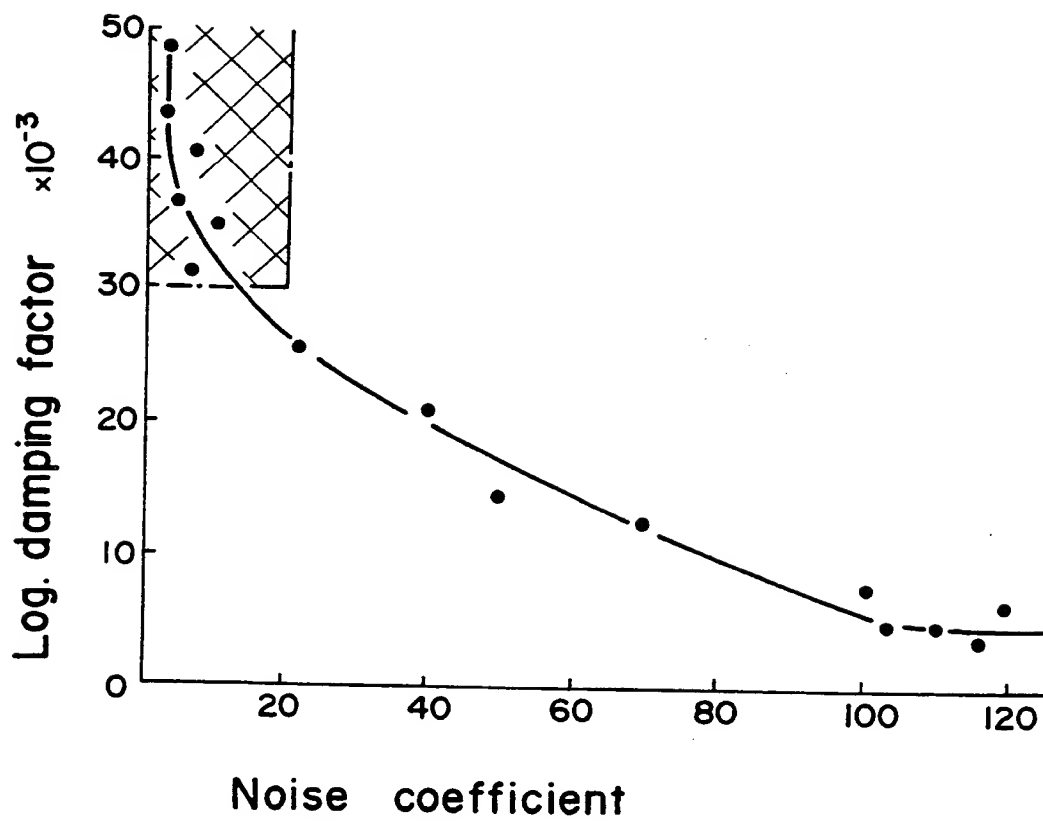


Fig. 5



ALLOY FOR DISK ROTOR

The present invention relates to an alloy suitable for a disk rotor in a disk brake, in particular, of motor cars and which has the ability to dampen vibrations coupled with a high strength.

Disk brakes are used widely in motor cars. The disk brake is constructed so that a braking force can be exerted by pressing together a pair of friction pads on opposite sides of a disk rotor rotatable together with the wheels against both sides of the disk rotor by means of a hydraulic piston.

In such disk rotors small vibrations are inevitable at the time of braking due to friction engagement with friction pads and, if these vibrations increase, the noise level becomes a problem.

In order to decrease the noise level, an alloy high in the damping factor of vibrations has been used hitherto.

Such an alloy contains 2.5 to 2.8 wt.% of silicon, 0.5 to 0.9 wt.% of manganese, 0 to 0.3 wt.% of chromium, 0 to 0.3 wt.% of copper and 3.4 to 4.0 wt.% of carbon, the remainder being inevitable impurities and iron, this alloy has been used widely hitherto.

However, this conventional alloy used in disk rotors sacrifices tensile strength for the high damping factor of vibrations. Thus with this conventional alloy it was not always possible to obtain sufficient strength especially when utilized in disk brakes used under severe conditions.

The aim of the present invention is to provide an alloy suitable for disk rotors which combines the characteristics of a high damping factor of vibrations while improving the tensile strength, the inconvenience aforementioned is dissolved.

The alloy for disk rotor of the invention contains 2.3 to 3.0 wt.% of silicon, 1.0 to 3.0 wt.% of manganese, 0.2 to 1.0 wt.% of chromium, 0 to 2.0 wt.% of copper and 3.7 to 4.2 wt.% of carbon, the remainder being inevitable impurities and iron.

With reference to the accompanying drawings Fig. 1 through Fig. 4 are charts showing the effects of the formulation rates of respective ingredients on the logarithmic damping factor and the tensile strength, and Fig. 5 is a chart showing the relationship between the logarithmic damping factor and the noise coefficient.

The alloy for a disk rotor according to the invention having the composition aforementioned is formed into a disk-like disk rotor and utilized in the disk brake. In this case, since the alloy itself has a high damping factor of vibrations and high tensile strength, the disk rotor does not vibrate so much as to generate unacceptable noise even when it vibrates upon braking accompanying with the friction with friction pads and yet to retain sufficient strength.

The invention is illustrated by the following Examples.

Example 1

The alloy for a disk rotor according to the invention was formulated to contain 2.72 wt.% of silicon, 2.5 wt.% of manganese, 0.5 wt.% of chromium and 3.78 wt.% of carbon, the remainder being inevitable impurities and iron.

The logarithmic damping factor of this alloy was found to be  $47 \times 10^{-3}$  while the tensile strength was 18 kgf/mm<sup>2</sup>.

The effects of the formulation rate of respective ingredients (Si, Mn, Cr, C) on the logarithmic damping factor and the tensile strength were determined, using the present example. The results are shown in Fig. 1 through Fig.4.

Fig. 1 shows the variations of logarithmic damping factor and tensile strength when varying the formulation rate of silicon alone, Fig. 2 the variations when varying similarly the formulation rate of manganese, Fig. 3 the variations when varying similarly the formulation of chromium and Fig. 4 the variations when varying the formulation rate of carbon, respectively.

In these Fig. 1 through Fig. 4, a circle ( ○ ) shows the tensile strength, a black circle ( ● ) the logarithmic damping factor and a double circle ( ⊙ ) the measurement values of these in said example 1, respectively. The area of oblique grating in the

charts represents the range of the present invention as defined in the claim.

As evident from the areas of oblique grating, the logarithmic damping factor is established within a range of not less than  $30 \times 10^{-3}$  in the invention. The establishment of this range is based on a following reason. The relationship between the logarithmic damping factor and the noise coefficient (product of the frequency with which noise generates and the strength of noise) as determined by experiment is as shown in Fig. 5. When the noise coefficient is not more than 20, there is hardly any noise. For this reason, the range of the logarithmic damping factor being less than  $30 \times 10^{-3}$ , where the noise coefficient is not more than 20, was determined in accordance with the invention.

#### Example 2

The alloy for disk rotor of the invention was formulated to contain 2.74 wt.% of silicon, 2.2 wt.% of manganese, 0.6 wt.% of chromium and 3.87 wt.% of carbon, the remainder being inevitable impurities and iron.

The logarithmic damping factor of this alloy, was found to be  $47 \times 10^{-3}$ , while, the tensile strength was 17 kgf/mm<sup>2</sup>.



Example 3

The alloy for a disk rotor according to the invention was formulated to contain 2.65 wt.% of silicon, 2.6 wt.% of manganese, 0.6 wt.% of chromium and 3.90 wt.% of carbon, the remainder being inevitable impurities and iron.

The logarithmic damping factor of this alloy, was found to be  $41 \times 10^{-3}$ , while the tensile strength was 19 kgf/mm<sup>2</sup>.

Example 4

The alloy for disk rotor according to the invention was formulated to contain 2.85 wt.% of silicon, 1.2 wt.% of manganese, 0.5 wt.% of chromium, 1.5 wt.% of copper and 3.85 wt.% of carbon, the remainder being inevitable impurities and iron.

The logarithmic damping factor of this alloy, was found to be  $41 \times 10^{-3}$ , while the tensile strength was 18 kgf/mm<sup>2</sup>.

Example 5

The alloy for disk rotor according to the invention was formulated to contain 2.75 wt.% of silicon, 1.0 wt.% of manganese, 0.6 wt.% of chromium, 1.8 wt.% of copper and 4.16 wt.% of carbon, the remainder being inevitable impurities and iron.

The logarithmic damping factor of this alloy, was found to be  $31 \times 10^{-3}$ , while the tensile strength was  $20 \text{ kgf/mm}^2$ .

Comparison of the results as above with the measurement values of a conventional disk rotor (particularly such one that does not take the damping of vibrations into consideration) and those of conventional vibration-damping disk rotor having the composition aforementioned is shown in the following table.

Table

		Si wt. %	Mn wt. %	Cr wt. %	Cu wt. %	C wt. %	Logarithmic damping factor $\times 10^{-3}$	Tensile strength $\text{kgf/mm}^2$
Conventional article	General rotor	1.9 -2.5	0.6 -0.9	0 -0.2	0 -0.4	3.0 -3.4	5 -10	20 -30
	Damping rotor	2.5 -2.8	0.5 -0.9	0 -0.3	0 -0.3	3.4 -4.0	20 -35	12 -14
Article of the invention	Example 1	2.72	2.5	0.5	0	3.78	47	18
	Example 2	2.74	2.2	0.6	0	3.87	47	17
	Example 3	2.65	2.6	0.6	0	3.90	41	19
	Example 4	2.85	1.2	0.5	1.5	3.85	41	18
	Example 5	2.75	1.0	0.6	1.8	4.16	31	20

As evident from this table and also from Fig. 1 through Fig. 4 aforementioned, the alloy for a disk rotor, according to the invention has a damping factor of vibration equal to or higher than that of conventional vibration-damping disk rotor and yet have higher tensile strength than that of a conventional vibration-damping rotor.

If the amount of manganese is raised above 3.0 wt.% there appears the harmful effect of increased hardness resulting in brittleness which makes processing difficult.

Since the alloys for disk rotor of the invention are constituted as mentioned above, they are very effective in industry as alloys which prevent noise and yet have high strength.

CLAIMS

1. An alloy for a disk rotor utilized in a disk brake which contains 2.3 to 3.0 wt.% of silicon, 1.0 to 3.0 wt.% of manganese, 0.2 to 1.0 wt.% of chromium, 0 to 2.0 wt.% of copper and 3.7 to 4.2 wt.% of carbon, the remainders being inevitable impurities and iron.
2. A disk rotor comprising an alloy according to claim 1.